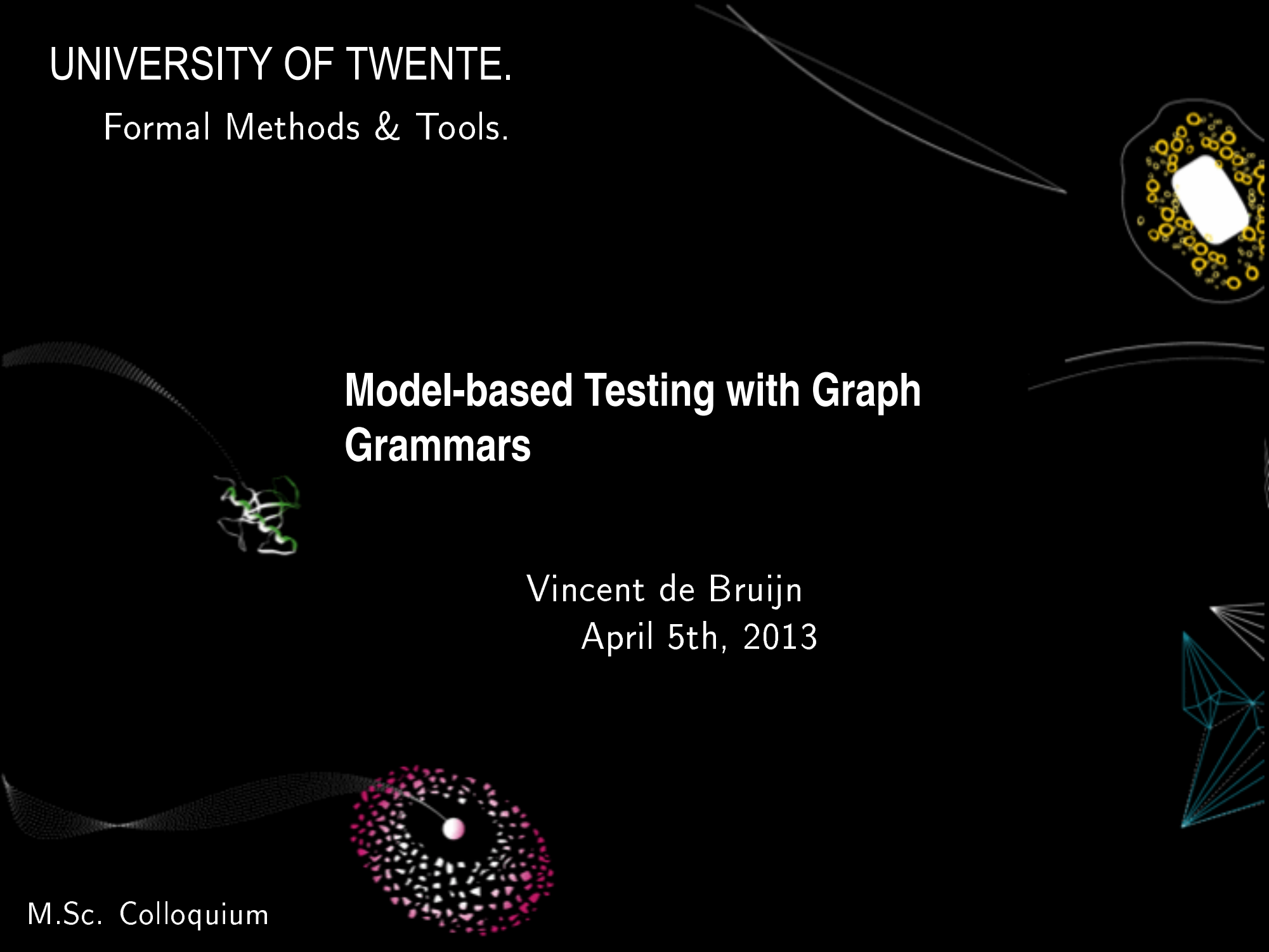
UNIVERSITY OF TWENTE.

Formal Methods & Tools.



Model-based Testing with Graph Grammars

Vincent de Bruijn

April 5th, 2013

M.Sc. Colloquium

Contents

Testing (1/3)

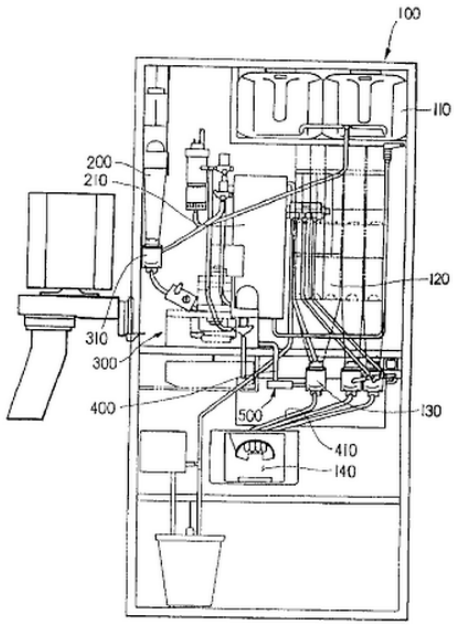
- Why do we test?
  - Products have requirements
  - Software implementation should uphold requirements

Testing (2/3)

- Creating tests manually:
  - Error-prone
  - Time intensive

Testing (3/3)

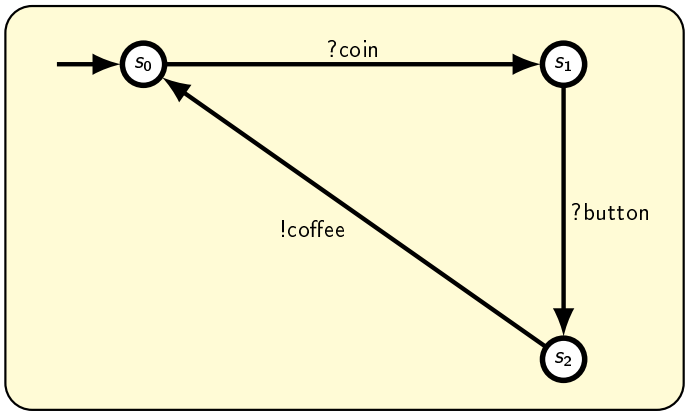
- Solution
  - Create ‘model‘ from the requirements
  - Generate tests automatically using model



Models (1/2)

Model

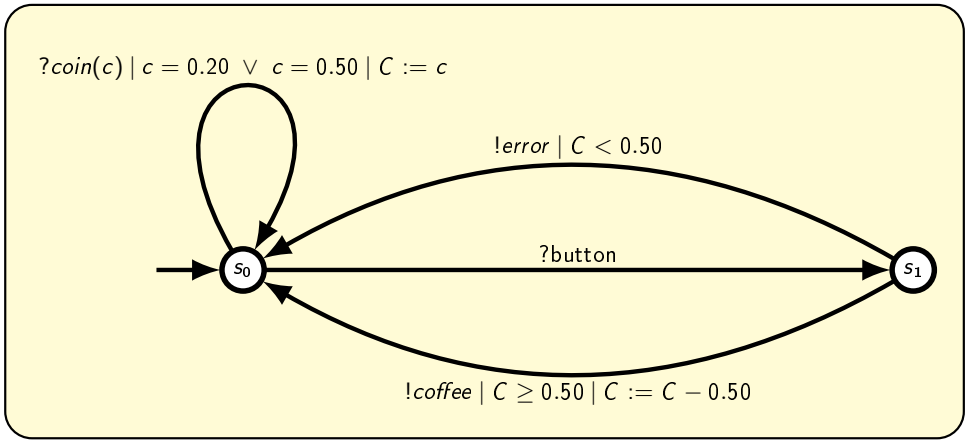
- An abstract representation of the behavior of a system



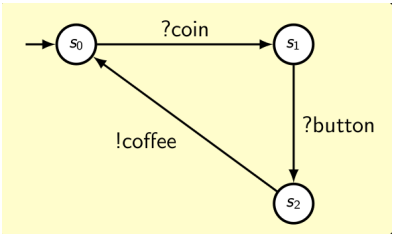
Models (2/2)

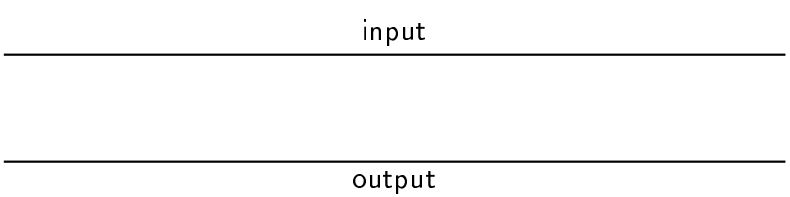
Symbolic Transition System (STS)

- Transition system with *variables*, *constraints* and *updates*



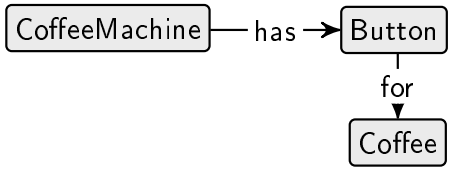
Model-based Testing (1/1)





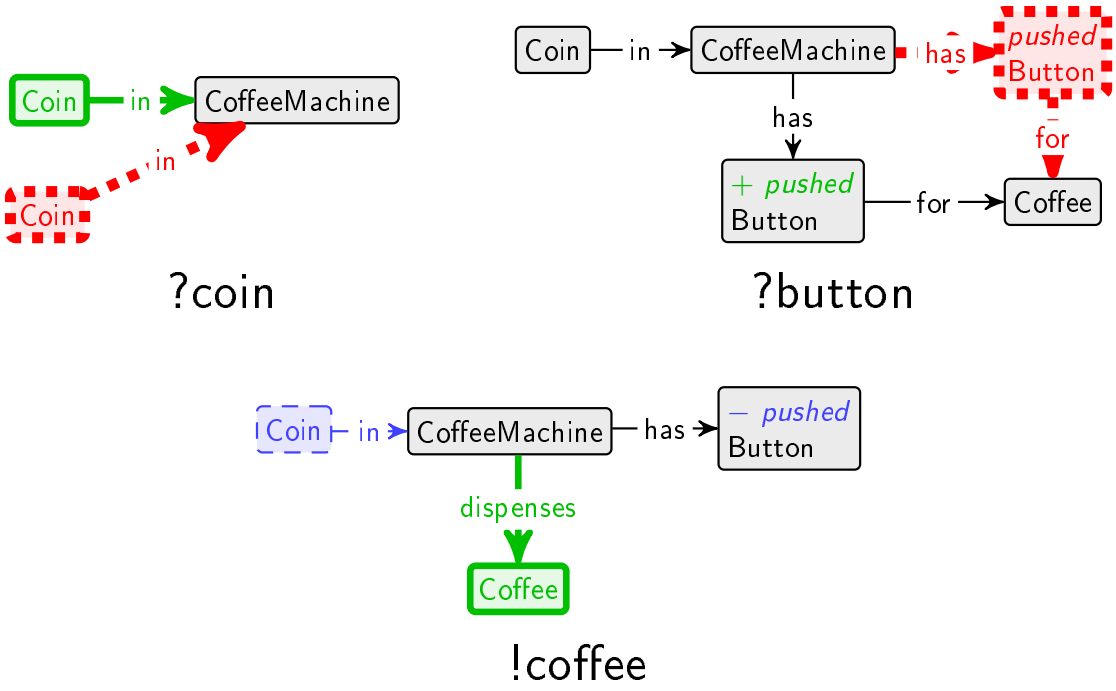
1. Take possible stimulus from model
2. Apply stimulus to SUT
3. Observe response(s)
4. Check if according to model
5. Notify tester whether test passed or failed

Graph Grammars (1/3)



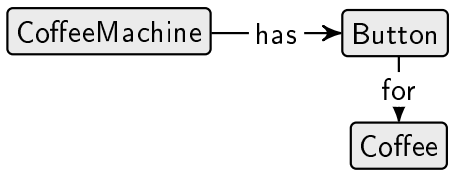
- Graphs represent system states
- Graph rules express possible changes to graph
- All possible changes make a *Graph Transition System*

Graph Grammars (2/3)

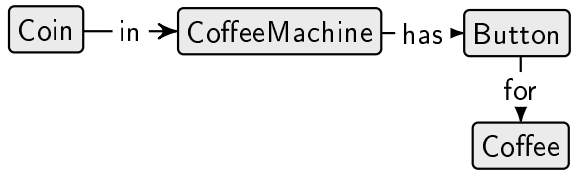


- Black and blue parts have to be present in graph
- Red parts may not be present in graph
- Blue is erased from graph
- Green is added to graph

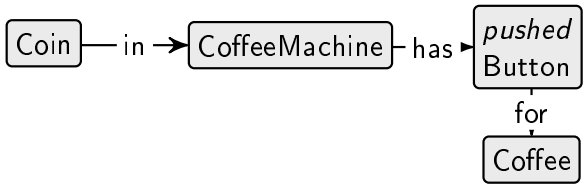
Graph Grammars (3/3)



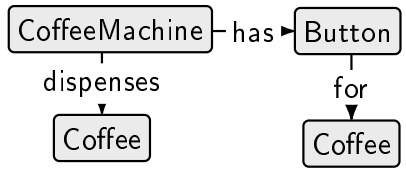
start



after ?coin



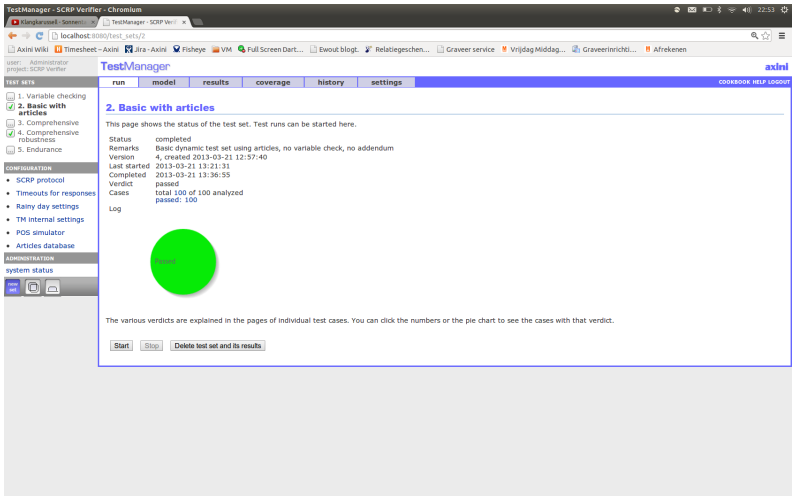
after ?button



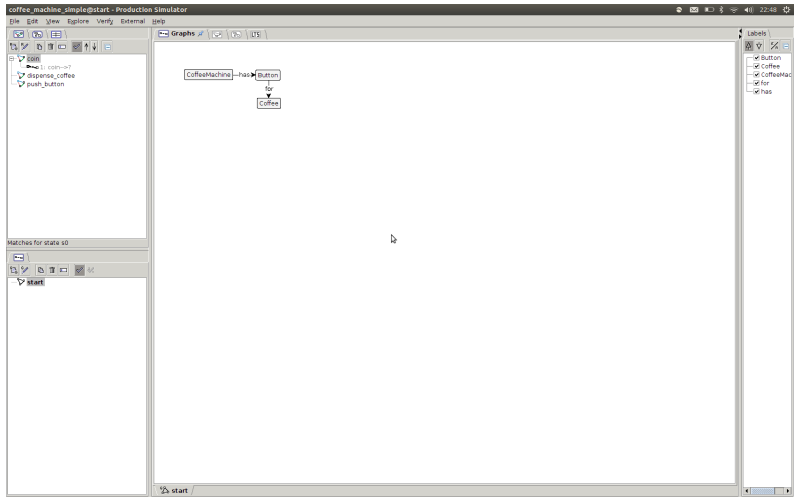
after !coffee

Tools or how I got to do this research

- Axini Test Manager (ATM) (uses STSs)
- GRaphs for Object-Oriented VErification (GROOVE) (uses Graph Grammars)



ATM



GROOVE

Research Goals

- Goals
  - Use GROOVE and ATM to create model-based testing tool with Graph Grammars
  - Validate this tool using case studies
- Motivation
  - Graphs are well-known and often used to represent system states
  - Rules are useful for describing computations

Contents

Contents

Setup

- Make a tool GRATiS (GRoove-Axini Testing System)
  1. Make a model of system with Graph Grammars
  2. Generate STS from Graph Grammar
  3. Model-based test system with STS

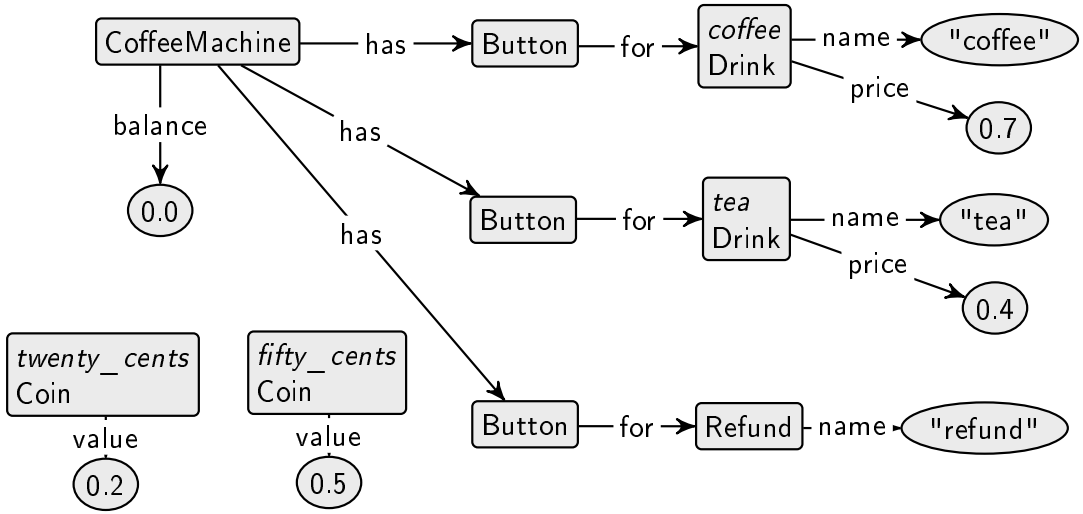
Contents

Case study: Coffee machine (1/9)

Requirements:

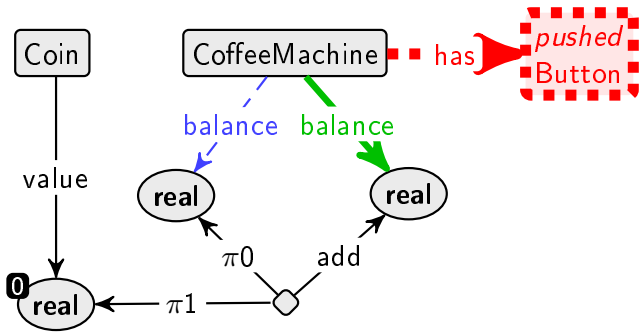
- Dispense coffee and tea
- Coffee costs 0.70 cts, tea costs 0.40 cts
- 0.20 and 0.50 cent coins can be entered
- Entered coins can be refunded
- Machine gives error when drink requested but not enough coins entered.

Case study: Coffee machine (2/9)



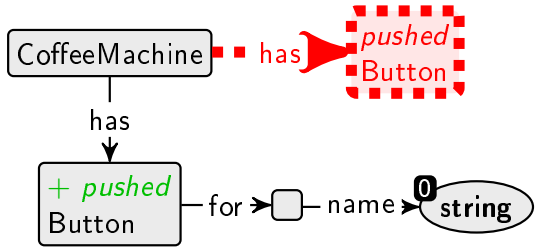
Coffee Machine start graph

Case study: Coffee machine (3/9)



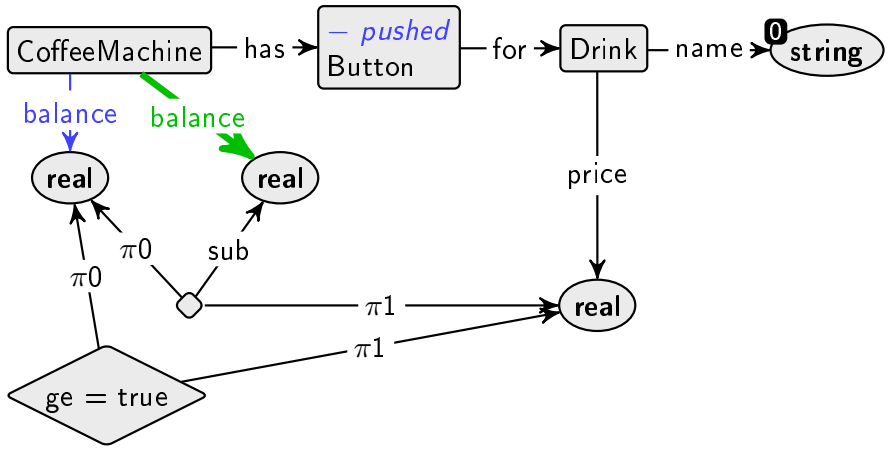
?coin(c)

Case study: Coffee machine (4/9)



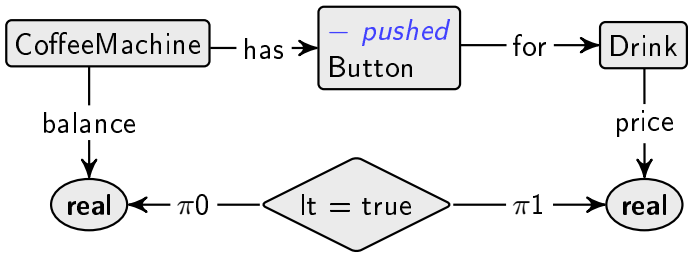
?button(b)

Case study: Coffee machine (5/9)



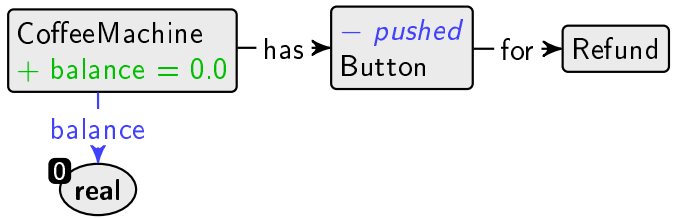
!drink(d)

Case study: Coffee machine (6/9)



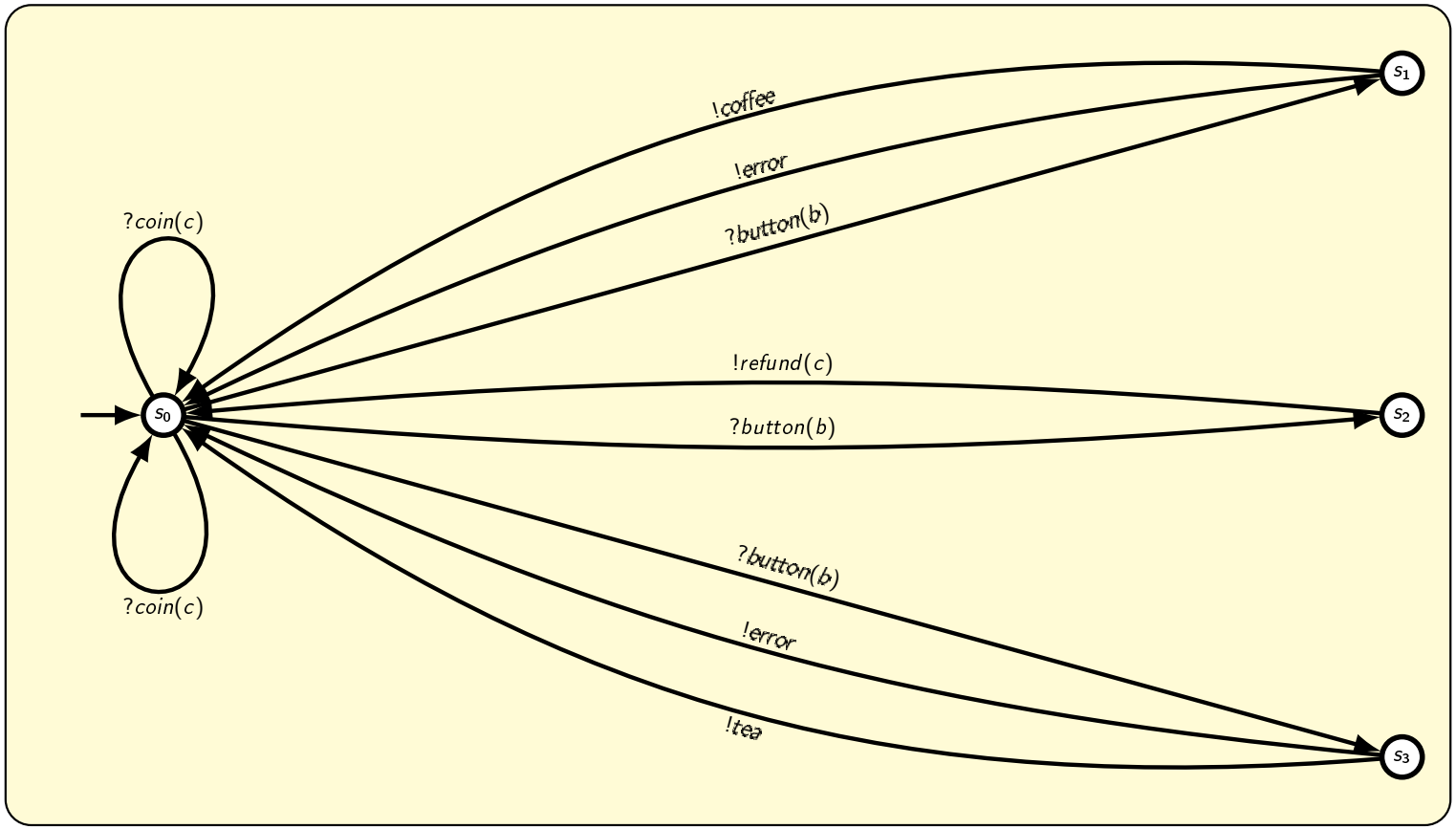
!error

Case study: Coffee machine (7/9)

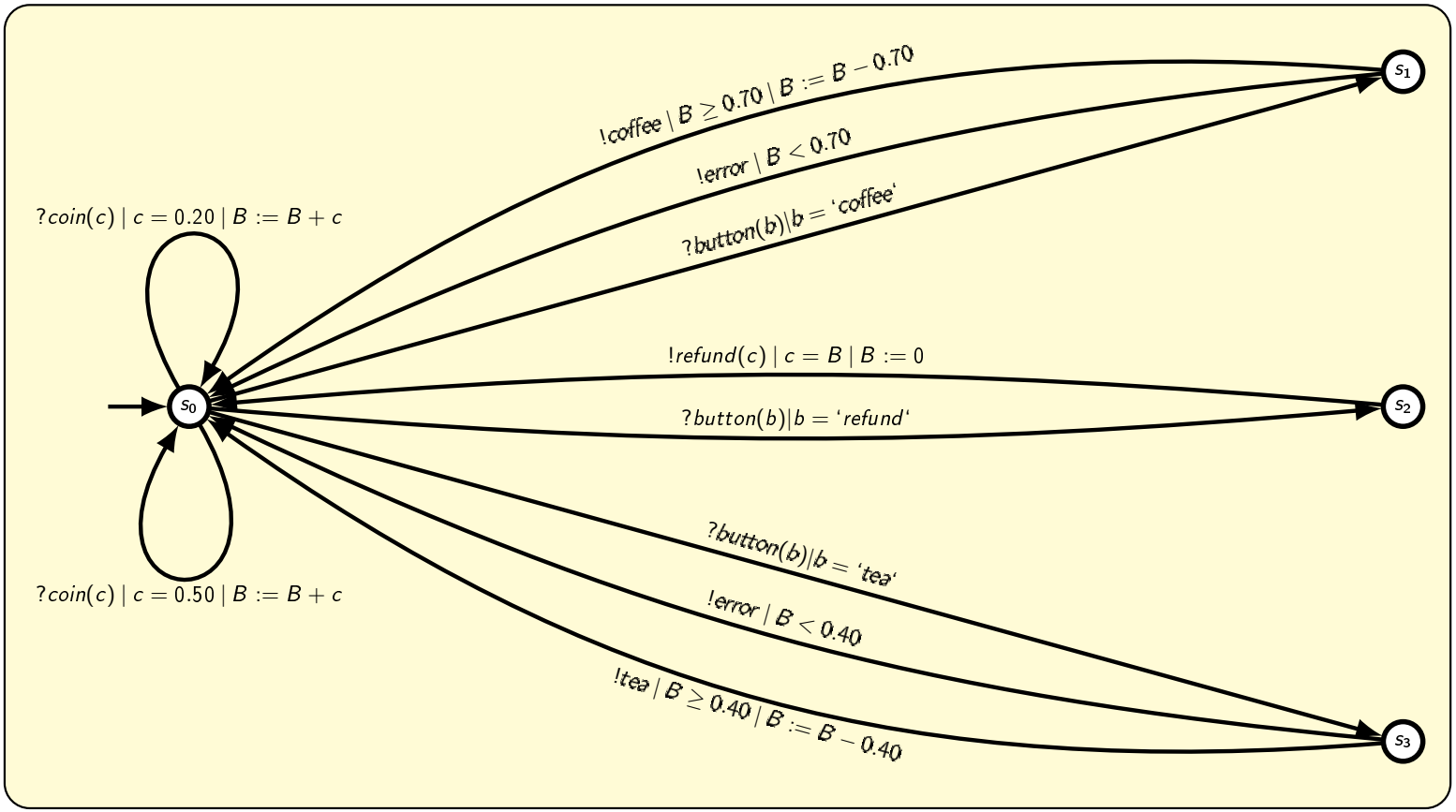


!refund(b)

Case study: Coffee machine (8/9)

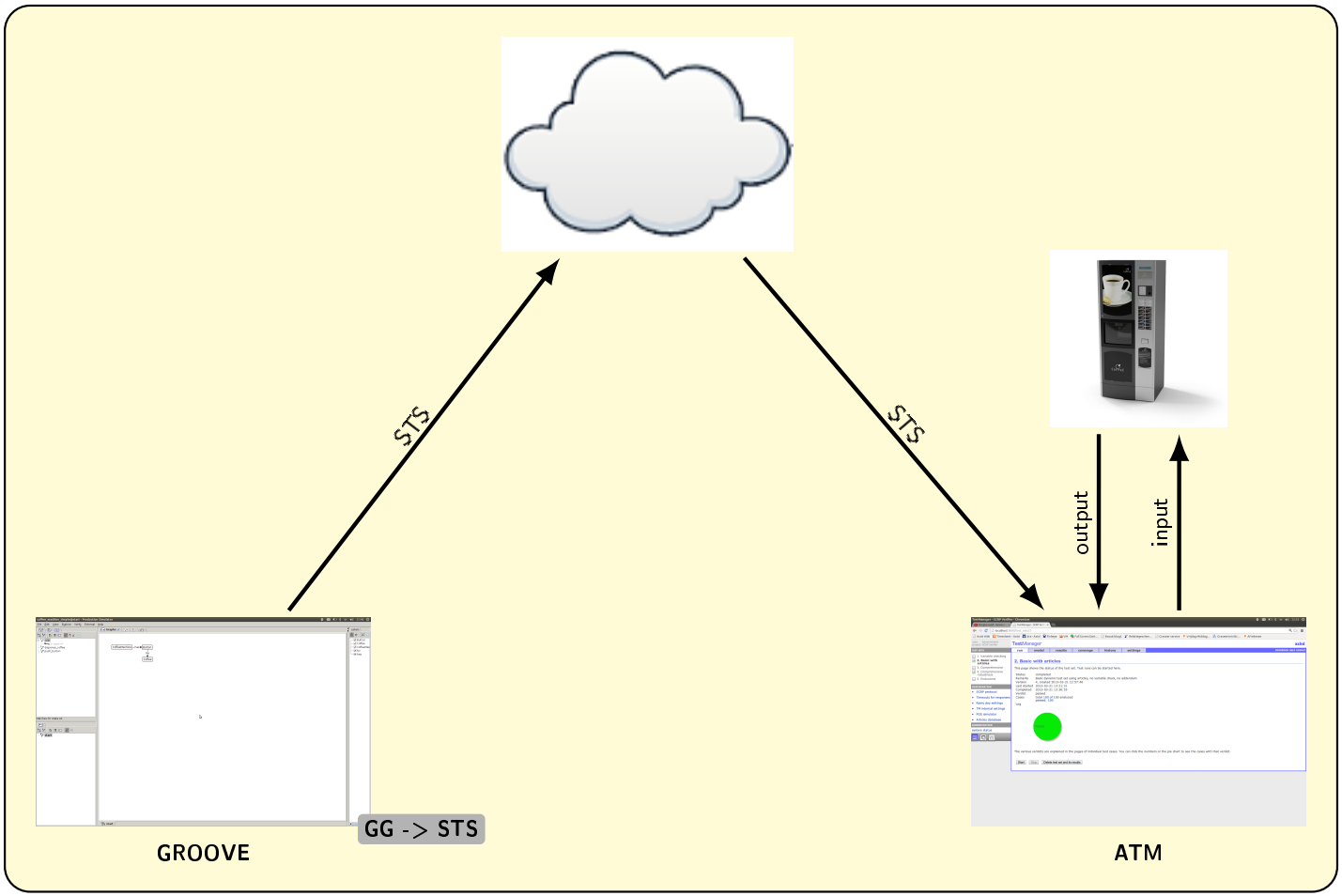


Case study: Coffee machine (9/9)



Contents

Implementation



Contents

Model Examples

- 5 example cases used:
  1. a boardgame
  2. a puzzle
  3. a reservation system
  4. a bar tab system
  5. a self-checkout register
- Model examples with Graph Grammar and STS
- Compare models

Measurements

- Performance (How fast does GRATiS make STS?)
- Simulation (Does the STS built by GRATiS express the same behavior as the modelled STS?)
- Redundancy (Is the STS built by GRATiS larger than the modelled STS?)
- Model complexity (Is there a difference in complexity between the STS and the Graph Grammar?)
- Extendability (How easy is it to adapt both models to a hypothetical extension?)

Measurement conclusions

- Performance: less than 10 seconds for large case study
- Simulation: No problems found
- Redundancy: Technique can create redundant STSs
- Model complexity: Both are equally complex
- Extendability: Varying results

Contents

Conclusion

- Created method of generating STSs from Graph Grammars
- Implemented a tool for model-based testing with Graph Grammars
- Validated the tool using case studies
- Showed modelling behavior with Graph Grammars is effective